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Title: A SEMICONDUCTOR DEVICE HAVING A MOVABLE MEMBER THEREIN AND A PROTECTIVE MEMBER DISPOSED THEREON

TRANSLATION STATEMENT
UNDER RULE 52(d)
FOR APPLICATION FILED IN FOREIGN LANGUAGE

Honorable Commissioner of Patents and Trademarks
Washington, D.C. 20231

Sir:

The undersigned, of the below address, hereby states that he/she well knows both the English and Japanese languages, and that the attached is an accurate translation into the English language of the above-identified application, which was/is being filed in the aforesaid foreign language.

Signed this 8th day of April, 2004

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[TITLE OF THE INVENTION] SEMICONDUCTOR DEVICE AND METHDO FOR MANUFACTURING THE SAME

[STATEMENT OF CLAIMS]

[CLAIM 1]

A method for producing a semiconductor device in such a manner that a semiconductor wafer (11) covered with a protective sheet (1) on one side thereof is divided into a plurality of chips by dicing-cut, the method comprising the steps of:

fixing a protective sheet to a jig (4) at an opposite side opposite to the one side of the protective sheet, the one side to be covered with the semiconductor wafer;

removing a dicing-cut region of the protective sheet while the protective sheet is fixed to the jig;

bonding the semiconductor wafer to the protective sheet at the one side of the protective sheet after the step of removing, while the protective sheet is fixed to the jig;

detaching the protective sheet and the semiconductor wafer from the jig; and

cutting the semiconductor wafer along the dicing-cut region (6) of the protective sheet by dicing so that the semiconductor wafer is divided into multiple chips.

[CLAIM 2]

The method of claim 1, further comprising:

forming a pad portion (21) on a surface of the semiconductor wafer (11), the pad portion electrically connecting to an external circuit;

removing a pad region of the protective sheet together with the dicing-cut region in the step of removing the dicing-cut region, the pad region of the protective sheet corresponding to the pad portion;

bonding the semiconductor wafer to the protective sheet in the step of bonding them in such a manner that the pad portion is exposed from an opening portion (23), which is formed by removing the pad region of the protective sheet; and

bonding a wire (33) to the pad portion of each chip exposed from the opening portion of the protective sheet after the step of cutting the semiconductor wafer into multiple chips.

[CLAIM 3]

The method of claim 1 or 2, wherein the dicing-cut region of the protective sheet (1) is removed by a cutting device in the step of removing the dicing-cut region.

[CLAIM 4]

The method of any one of claims 1-3, wherein the protective sheet (1) is made of a heat-contraction type plastic film.

[CLAIM 5]

The method of any one of claims 1-4, further comprising the step of:

attaching a back side sheet (42) to the semiconductor wafer at an opposite side of the semiconductor wafer opposite to the protective sheet before cutting the semiconductor wafer, the back side sheet protecting the opposite side of the semiconductor wafer.

[CLAIM 6]

The method of any one of claims 1-5, wherein the protective sheet (1) is fixed to the jig (4) by vacuum absorption.

[CLAIM 7]

A semiconductor device comprising:

a semiconductor chip (200, 300, 400, 500) provided by cutting a semiconductor wafer (11) by dicing; and

a protective member (14, 51, 63, 73) disposed on one side of the semiconductor chip, the protective member protecting the semiconductor chip when the semiconductor wafer is cut by dicing,

wherein a peripheral edge portion of the protective member is provided at an inside of a peripheral edge portion of the semiconductor chip.

[CLAIM 8]

A semiconductor device comprising:

a semiconductor chip (500) provided by cutting a semiconductor wafer (11) by dicing;

a protective member (73) disposed on a surface of the semiconductor chip and having an opening portion (72) from which the surface of the semiconductor chip is exposed, the protective

member being for protecting the semiconductor chip when the semiconductor wafer is cut by dicing; and

a bump (70) disposed on the surface of the semiconductor chip in such a manner that the bump is exposed from the opening portion, the bump electrically connecting to an external circuit.

[CLAIM 9]

A method for producing a semiconductor device in such a manner that a semiconductor wafer (11) covered with a protective sheet (1) on one side thereof is divided into a plurality of chips by dicing-cut, the method comprising the steps of:

preparing a semiconductor wafer and a protective sheet;

forming a bump (70) on a main surface of the semiconductor wafer, the bump electrically connecting to an external circuit;

forming an opening portion (72) in the protective sheet by removing a region of the protective sheet corresponding to the bump;

bonding the main surface of the semiconductor wafer to the protective sheet so that the bump is exposed from the opening portion, which is formed by removing the region corresponding to the bump; and

cutting the semiconductor wafer by dicing to form multiple semiconductor devices.

[CLAIM 10]

The method of claim 9, further comprising the steps of:

preparing a substrate (80) having a conductive portion (81) thereon;

disposing the semiconductor device (500) on the substrate, the semiconductor device obtained in the step of cutting the semiconductor wafer; and

electrically connecting the bump (70) to the conductive portion.

[DETAILED DESCRIPTION OF THE INVENTION]

[0001]

[FIELD OF THE INVENTION]

This invention relates to a method for producing a semiconductor device by dicing a semiconductor wafer covered with a protective sheet along with scribe lines and a semiconductor device produced by the method.

[0002]

[RELATED ART]

As disclosed in many documents such as JP-A-10-242253, JP-A-7-99172, USP. No. 5,824,177, and USP. No. 5,362,681, when a semiconductor wafer having plural movable portions is divided into plural chips, a protective sheet (a protective member) is attached to the semiconductor wafer to protect the movable portions. In this state, the semiconductor wafer is diced into the chips together with the protective sheet at a dicing-cut step.

[0003]

[OBJECT OF THE INVENTION]

In the conventional method described above, however, because the protective sheet is diced together with the semiconductor wafer, scraps of the protective sheet (e.g., adhesive organic particles

having a certain degree of adhesive force) are produced by cutting and attached to the chips as contaminants. The scraps may be attached to electrodes formed on each chip to adversely affect the electrodes in electrical and mechanical connection so that the chips are contaminated by the scraps. The electrode connects to an external circuit for sending signals.

[0004]

Further, in the conventional method, the protective sheet needs to be removed from the chips after the dicing-cut step is carried out. If the protective sheet is bonded to the semiconductor wafer firmly, the removal of the protective sheet is difficult and may cause damages to the chips by a stress. Therefore, the protective sheet is bonded to the semiconductor wafer at relatively small adhesion. Because of this, the protective sheet is easily separated from the semiconductor wafer by hitting a blade of the dicing on the protective sheet during the dicing-cut step. As a result, the protective layer cannot protect the movable portions sufficiently.

[0005]

The present invention has been made in view of the above problems. An object of the present invention is to provide a semiconductor device and a method for producing the semiconductor device. The semiconductor device is prevented from being contaminated by scraps of a protective sheet produced when a semiconductor wafer covered with the protective sheet is cut by dicing to form the semiconductor device. Another object of the present invention is to provide a semiconductor device and a method

for producing the semiconductor device capable of preventing separation of the protective sheet.

[0006]

[CONSTITUTION FOR ACHIEVING THE OBJECT OF THE INVENTION]

To achieve the object of the present invention, a method for producing a semiconductor device claimed in claim 1, includes the steps of: fixing a protective sheet (1) to a jig (4) at an opposite side opposite to the one side of the protective sheet (1), the one side to be covered with a semiconductor wafer (11); removing a dicing-cut region of the protective sheet while the protective sheet is fixed to the jig; bonding the semiconductor wafer to the protective sheet at the one side of the protective sheet after the step of removing, while the protective sheet is fixed to the jig; detaching the protective sheet and the semiconductor wafer from the jig, the semiconductor wafer being bonded to the protective sheet; and cutting the semiconductor wafer along the dicing-cut region (6) of the protective sheet by dicing so that the semiconductor wafer is divided into multiple chips.

[0007]

In the method described above, even when the dicing-cut region of the protective sheet is removed, the protective sheet does not separate from the semiconductor wafer since the protective sheet is fixed to the jig. In the step of dicing-cut process, since the dicing-cut region of the protective sheet is preliminarily removed, any scraps of the protective sheet are not produced by dicing. As a result, the semiconductor device is not contaminated by the scraps. Further, because a dicing blade does not contact the protective sheet

easily, the separation of the protective sheet is not caused by the dicing blade.

[0008]

Accordingly, the method for producing the semiconductor device according to claim 1 provides to prevent the chip from being contaminated by the scraps of protective sheet formed by dicing. Further, the method provides to prevent separation of the protective sheet.

Preferably, in the method claimed in claim 2, the semiconductor wafer (11) includes a pad portion (21) for electrically connecting to an external circuit.

[0009]

Specifically, the method claimed in claim 2 includes the steps of: forming a pad portion (21) on a surface of the semiconductor wafer (11), the pad portion electrically connecting to an external circuit; removing a pad region of the protective sheet together with the dicing-cut region in the step of removing the dicing-cut region, the pad region of the protective sheet corresponding to the pad portion; bonding the semiconductor wafer to the protective sheet in the step of bonding them in such a manner that the pad portion is exposed from an opening portion (23), which is formed by removing the pad region of the protective sheet; and bonding a wire (33) to the pad portion of each chip exposed from the opening portion of the protective sheet after the step of cutting the semiconductor wafer into multiple chips.

[0010]

In the method described above, adding effects and functions

obtained by the method claimed in claim 1, the wire is bonded to the pad portion of the chip together with the protective sheet, both of which are cut by dicing. Therefore, it is not necessitated for the protective sheet to remove after the step of cutting by dicing blade. Thus, the protective sheet can be bonded to the semiconductor wafer firmly. Therefore, the separation of the protective sheet can be prevented much securely.

Further, the method claimed in claim 3 provides a specific removing means in the step of removing. The method is characterized in that the dicing-cut region of the protective sheet is removed by a cutting device.

[0011]

In the method claimed in claim 4, the protective sheet (1) is made of a heat-contraction type plastic film. In this case, after the protective sheet is removed, the dicing-cut region of the protective sheet becomes smaller since the dicing-cut region is expanded by thermal shrinkage of the protective sheet. Further, when the semiconductor wafer is cut along the dicing-cut region, the dicing blade easily cut the semiconductor wafer since the dicing blade does not contact the protective sheet substantially.

[0012]

More preferably, the method claimed in claim 5 further includes the step of attaching a back side sheet (42) to the semiconductor wafer (11) at an opposite side of the semiconductor wafer opposite to the protective sheet before cutting the semiconductor wafer, the back side sheet protecting the opposite side of the semiconductor wafer. In this case, a movable portion

is effectively protected by the back side sheet in a case where the semiconductor wafer has a construction such that the movable portion is exposed on both sides of the semiconductor wafer.

Further, in the method claimed in claim 6, the protective sheet (1) is fixed to the jig (4) by vacuum absorption. In this case, the protective sheet can be fixed to the jig and be detached from the jig readily without being damaged.

[0013]

Further, a semiconductor device comprising: a semiconductor chip (200, 300, 400, 500) provided by cutting a semiconductor wafer (11) by dicing; and a protective member (14, 51, 63, 73) disposed on one side of the semiconductor chip, the protective member protecting the semiconductor chip when the semiconductor wafer is cut by dicing. Here, a peripheral edge portion of the protective member is provided at an inside of a peripheral edge portion of the semiconductor chip.

[0014]

In the above semiconductor device, the peripheral edge portion of the protective member is provided at the inside of the peripheral edge portion of the semiconductor chip. Therefore, the dicing blade does not contact the protective member substantially when the semiconductor wafer is cut by dicing. Therefore, no scrap of the protective sheet is produced by dicing. Further, the separation of the protective sheet is not caused by the dicing blade.

Since the semiconductor chip is covered with the protective member after the semiconductor wafer is cut by dicing, the protective sheet can be bonded to the semiconductor wafer firmly. Therefore,

the separation of the protective sheet can be prevented much securely.

[0015]

If the peripheral edge portion of the protective member is disposed at the peripheral edge portion of the semiconductor chip, the protective member is easily separated because the side surface of the chip or the upper periphery (i.e., the peripheral edge portion) of the chip is gripped while the chip is treated. Thus, a problem of reliability happens in the above case. However, in the semiconductor device according to claim 7, the peripheral edge portion of the protective member is provided at the inside of the peripheral edge portion of the semiconductor chip. Therefore, the protective member is prevented from being removed when the chip is gripped because the protective member is not touched.

[0016]

Accordingly, the chip is not contaminated by the scraps of the protective sheet produced by dicing. Further, the separation of the protective sheet is not caused by the dicing blade. Here, the semiconductor device claimed in claim 7 can be appropriately produced by the method claimed in claim 1 or claim 7.

Further, a semiconductor device claimed in claim 8 includes: a semiconductor chip (500) provided by cutting a semiconductor wafer (11) by dicing; a protective member (73) disposed on a surface of the semiconductor chip having an opening portion (72) from which the surface of the semiconductor chip is exposed, the protective member being for protecting the semiconductor chip when the semiconductor wafer is cut by dicing; and a bump (70) disposed on

a surface of the semiconductor chip in such a manner that the bump is exposed from the opening portion, the bump electrically connecting to an external circuit.

[0017]

In the semiconductor device claimed in claim 8, the protective member can be bonded to the semiconductor chip firmly since the semiconductor chip is still covered with the protective member. Therefore, the chip is prevented from being contaminated by the scraps, and the separation of the protective sheet is not caused by the dicing blade. Further, the semiconductor device can be electrically connected to the external circuit such as an external circuit board by the bump exposed from the opening portion even though the semiconductor chip is still covered with the protective member.

[0018]

The semiconductor device claimed in claim 8 can be produced by the method claimed in claim 9 appropriately. The semiconductor device claimed in claim 8 can be mounted on the substrate (80) as an external circuit board by the method claimed in claim 10.

A reference number in each bracket of the above means corresponds to the specific means described in the following embodiments.

[0019]

[PREFERRED EMBODIMENTS OF THE INVENTION]

Preferred embodiments of the present invention are explained with reference to accompanying drawings. In the embodiments, a semiconductor wafer means a wafer before and after a dicing-cut step

is carried out provided that the wafer has a contour of its initial state.

(First Embodiment)

In a first preferred embodiment, a method for producing a semiconductor device according to the present invention is applied to various semiconductor devices including movable portions such as a surface micro-processed type acceleration sensor, a rotation angle sensor, and a reflecting digital micro-mirror projector (DMD).

[0020]

FIGS. 1(a) to 1(e) and 2(a) to 2(c) are cross sectional views explaining a method for producing a semiconductor device according to the first embodiment. The method in the first embodiment is explained referring to FIGS. 1(a) to 1(e) and 2(a) to 2(c).

First, as shown in FIG. 1(a), a protective sheet 1 is prepared. The protective sheet 1 is formed from an UV-setting adhesive sheet, a base of which is made of, for example, polyolefine. The protective sheet 1 has an adhesive surface 1a for covering a semiconductor wafer 11. Further, a jig 4 shown in FIG. 1(b) is disposed on a heater block (not shown). The jig 4 has recesses 2 and holes 3 for vacuum absorption. The heater block performs the vacuum absorption in cooperation with the holes 3 of the jig 4.

[0021]

Next, at a jig fixation step shown in FIG. 1(c), the protective sheet 1 is disposed on the jig 4 with a surface 1b contacting the jig 4 and the adhesive surface 1a of the protective sheet 1 exposed upward. Here, the surface 1b of the protective sheet 1 is disposed at an opposite side of the adhesive surface 1a. Then, the protective

sheet 1 is dented along the recesses 2 by vacuum absorption performed through the holes 3.

Because the jig 4 is heated to a temperature in a range of 40 to 200 ℃, cap portions (i.e., protective cap portions) 5 are formed on the protective sheet 1 with shapes corresponding to the recesses 2. The protective sheet 1 is fixed to the jig 4 by an attraction through the holes 3.

[0022]

At a protective sheet region removal step shown in FIG. 1(d), the jig 4 is detached from the heater block along with the protective sheet 1 fixed to the jig 4. The jig 4 is then disposed on a base (not shown), which can absorb under vacuum as the heater block.

Then, regions (i.e., dicing-cut regions) of the protective sheet 1 where dicing-cut is to be performed at a dicing-cut step described below are removed by cutting with a cutting means such as a press method, a cutter or an excimer laser scribing method, so that grooves 6 are formed at the removed regions. As a result, the protective sheet 1 is divided into regions having sizes approximately the same as those of semiconductor chips to be formed.

[0023]

At this step, because the protective sheet 1 is fixed to the jig 4 by vacuum absorption, the protective sheet 1 is not loosed into pieces after the protective sheet region removal step is carried out.

Next, at a wafer bonding step, the semiconductor wafer (e.g., a silicon substrate and the like) 11 having movable portions 10 is bonded to the protective sheet 1 fixed to the jig 4 by adhesives

so that the movable portions 10 face the cap portions 5. The protective sheet 1 may be a pressure sensitive adhesive sheet so that the semiconductor wafer 11 is bonded thereto. The positioning between the protective sheet 1 and the semiconductor wafer 11 is performed by alignment keys formed on the protective sheet 1 and the semiconductor wafer 11 or by a CCD camera.

[0024]

A roller may be rolled on the semiconductor wafer 11 by heating the semiconductor wafer 11 so that the semiconductor wafer 11 can be bonded to the protective sheet 1 without producing voids in the adhesives and lessening adhesion of the adhesives.

Then, a dicing sheet 12 is attached to the other surface of the semiconductor wafer 11 at an opposite side of the movable portions 10. The dicing sheet 12 may be attached to the semiconductor wafer 11 before the semiconductor wafer 11 is bonded to the protective sheet 1.

[0025]

By performing the wafer bonding step described above, as shown in FIG. 1(e), the semiconductor wafer 11 is attached to protective members (protective caps) 14 at one surface, and is attached to the dicing sheet 12 at the other surface. Each of the protective members 14 has a corresponding one of the cap portions 5 and a size the same as that of each semiconductor chip, and is attached to the semiconductor wafer 11 while being fixed to the jig 4. In FIG. 1(e), although only one movable portion 10 is indicated in each chip region, several movable portions 10 are provided in each chip region usually.

[0026]

Successively, at the dicing-cut step shown in FIG. 2(a), after the jig 4 is detached from the protective sheet 1 (protective members 14), the semiconductor wafer 11 is fixed to a dicing base 13 by vacuum absorption. In FIG. 2(a), a detailed structure of the dicing base 13 is omitted. Then, the dicing-cut is performed along the grooves 6 where the protective sheet 1 is removed, whereby the semiconductor wafer 11 is divided into the semiconductor chips. At that time, the dicing sheet 12 is not cut completely.

[0027]

Thus, the semiconductor wafer 11 is divided into multiple semiconductor chips. The semiconductor chips are protected by the respective protective members (i.e., protective chaps) 14.

In this dicing-cut step, the protective sheet 1 is not cut. Therefore, any scraps of the protective sheet 1 are not produced to remain on the semiconductor chips, thereby preventing contamination of the chips. In addition, because a cutting blade (i.e., a dicing blade) hardly contacts the protective members 14 at the dicing-cut step, separation of the protective members 14 is not caused by the dicing blade.

[0028]

Because the protective sheet 1 needs not be attached to the semiconductor wafer 11 so firmly, the removal of the protective members 14 is easy. At a protective member removal step, as shown in FIG. 2(b), a quartz glass jig 15 capable of performing vacuum absorption similarly to the jig 4 is disposed on the protective members 14 covering the semiconductor wafer 11. Then, UV irradiation is performed through the quartz glass jig 15 so that

the adhesive is hardened to have lessened adhesion, and the protective members 14 are removed by the vacuum absorption. Accordingly, the state, in which the protective member 14 is removed, is provided, as shown in FIG. 2(c).

[0029]

The quartz glass jig 15 may have recesses as the jig 4 described above. Otherwise, the quartz glass jig 15 may have only holes for vacuum absorption at positions corresponding to flat faces of the protective members 14. Each semiconductor chip (semiconductor device) 100 formed by removing the protective members 14 can be handled as an ordinal IC chips.

Although the quartz glass jig 15 is used to remove the protective members 14 in the present embodiment, other materials are usable as the jig 15 provided that the materials can transmit UV. The UV irradiation may be performed using a mirror or an optical fiber provided that the entire wafer surface is irradiated with UV.

[0030]

When the protective sheet 1 is made of a heat-contraction type plastic film, the grooves 6 are widened due to heat contraction of the protective sheet 1 after the protective sheet region removal step is carried out. Therefore, the removed regions of the protective portions 1 can be decreased. Also, because it is difficult for the dicing blade to contact the protective sheet 1 at the dicing-cut step, the dicing-cut step can be performed more readily along with the groove 6. Preferably, the heat-contraction type plastic film is selected from polyolefine family films such as a polyethylene film and a polypropylene film and films processed

by drawing such as a polyvinyl chloride film and a polyester film.

[0031]

In the present embodiment, the protective sheet 1 is fixed to the jig 4 by vacuum absorption. Therefore, the protective sheet 1 can be fixed to the jig 4 and be detached from the jig 4 readily without being damaged.

Also, because the protective sheet 1 is not cut at the dicing-cut step, the life-time of the cutting blade (i.e., the dicing blade) is improved.

[0032]

Thus, the method for producing the semiconductor device according to the first embodiment of the present invention provides to prevent the chip from being contaminated by the scraps of the protective sheet formed in the dicing-cut process. Further, the method provides to prevent the protective sheet from being removed.

(Second Embodiment)

In a second preferred embodiment, the protective members (protective caps) 14 are formed similarly to the first embodiment. Differences from the first embodiment are that the semiconductor wafer 11 has pad portions 21 for being electrically connected to external circuits by wire bonding (see FIG. 3(e)), and that the protective members 14 are not removed and remain in products (i.e., exist as a product). Therefore, the protective members 14 need to be partially removed at portions corresponding to the pad portions 21. The main differences from the first embodiment are described in more detail below.

[0033]

FIGS. 3(a) to 3(e), 4(a), and 4(b) schematically show the method for producing the semiconductor device in the second embodiment in a stepwise manner. The steps shown in FIGS. 3(a), 3(b) and 3(c) are performed in substantially the same manner as those shown in FIGS. 1(a), 1(b), and 1(c).

At a protective sheet region removal step shown in FIG. 3(d), regions of the protective sheet 1 where the dicing-cut is to be performed (i.e., the regions corresponding to the grooves 6) and regions of the protective sheet 1 corresponding to the pad portions 21 are removed as in the step shown in FIG. 1(d) to form opening portions 23. The regions corresponding to the pad portions 21 may be removed from the protective sheet 1 in a sheet state by pressing or the like before the protective sheet region removal step is carried out.

[0034]

Next, at a wafer bonding step shown in FIG. 3(e), the semiconductor wafer 11 is bonded to the protective sheet 1 so that the pad portions 21 are exposed to the opening portions 23, which is formed by removing the regions corresponding to the pad regions 21. Accordingly, both the pad portions 21 and dicing-cut portions 22 in the semiconductor wafer 11 are exposed to the respective opening portions 23. The other procedure at the wafer bonding step is substantially the same as that in the first embodiment.

[0035]

In the present embodiment, because the protective members 14 need not be removed, the protective sheet 1 can be bonded firmly. This is preferable to prevent the separation of the protective sheet

1.

The part of the pad portions 21 corresponding to the wire bonding pad may be partially exposed from respective windows (i.e., the pad portions 21 may be partially exposed).

[0036]

Next, as shown in FIG. 4(a), the dicing-cut step is carried out substantially in the same manner as in the first embodiment, thereby cutting the semiconductor wafer 11 into semiconductor chips (semiconductor devices) 200. In the present embodiment, as shown in FIG. 4(b), each semiconductor chip 200 holds each protective member 14 after the dicing-cut step is carried out.

After the dicing-cut step is carried out, the semiconductor chips 200 are detached from the dicing sheet 12. Then, a wire-bonding step is performed to each semiconductor chip 200 so that wires are bonded to the pad portions 21 exposed from the opening portion 23 of the protective member 14.

[0037]

FIG. 5 shows a semiconductor device to which the wire-bonding step is performed, as an example. A semiconductor acceleration sensor 31 formed as one of the semiconductor chips 200 is disposed on a substrate 30 (for example, ceramic substrate, printed circuit board, or lead frame) through adhesive (adhesive sheet) 32, silver paste or the like. Next, a wire 33 made of gold, aluminum, or the like is bonded onto a pad portion 21 and a terminal 34 disposed on the substrate 30. Thus, the wire-bonding step is carried out.

[0038]

FIG. 6 shows the acceleration sensor 31 (semiconductor chip

200) viewing from a side of the protective member 14. As shown in FIG. 6, the protective member 14 covers the acceleration sensor 31 except the dicing-cut portion 22 and the pad portions 21. The opening portion 23 is a portion not covered with the protective member 14.

[0039]

Further, FIG. 7(a) is a schematic cross sectional view showing the sensor 31 (i.e., the semiconductor chip 200), and FIG. 7(b) is a plan view showing the sensor viewing from the side of the protective member 14. FIGS. 7(a) and 7(b) show a case where the dicing-cut portion 22 and the pad portions 21 are partially exposed from the protective member 14, i.e., the opening portions 23 are formed to partially expose the dicing-cut portion 22 and the pad portions 21.

Thus, according to the present embodiment, in addition to the same effects as those in the first embodiment, the wire-bonding step can be performed without removing the protective sheet 1 (protective member 14) from the semiconductor chip 200. Because it is not necessary to remove the protective member 14 after the dicing-cut step, the protective sheet 1 can be bonded to the wafer firmly. As a result, the separation of the protective sheet 1 can be prevented more properly.

[0040]

(Third Embodiment)

FIGS. 8(a) to 8(f) show a method for producing a semiconductor device in a stepwise manner in a third preferred embodiment. In the first and second embodiments, the semiconductor wafer 11 is processed from one surface thereof. To the contrary, in the present

embodiment, the semiconductor wafer 11 is processed from front and back surfaces thereof. That is, as shown in FIG. 8(a), the semiconductor wafer 11 in the present embodiment has back surface processed portions 41 formed as opening portions by etching or the like performed from the back surface. The movable portions 10 are exposed from both front and back surfaces of the semiconductor wafer 11.

[0041]

At a back side adhesive sheet bonding step, an adhesive sheet (back side protective sheet) 42 is bonded to the back surface of the semiconductor wafer 11 to protect the back surface.

Further, at the wafer bonding step, the protective sheet 1, which is processed as in the first embodiment to have the grooves 6, is bonded to the front surface of the semiconductor wafer 11 while being fixed to the jig 4. This state is shown in FIG. 8(b).

[0042]

Then, as shown in FIG. 8(c), the protective sheet 1 is detached from the jig 4. After that, as shown in FIG. 8(d), the semiconductor wafer 11 is fixed to the dicing base 13 (not shown in FIG. 8(d)) by vacuum absorption through a dicing tape 12a at the side of the adhesive film 42. Then, the dicing-cut step is carried out as in the first embodiment. The dicing tape 12a has the same function as that of the dicing sheet 12, and is not cut completely.

[0043]

Accordingly, the semiconductor wafer 11 is divided into chips. As shown in FIG. 8(e), each chip is protected by the protective member 14 at the front surface side thereof, and by the adhesive film 42

at the back surface side thereof. Then, as in the first embodiment, the protective member 14 is removed, thereby providing a semiconductor chip (device) 300 shown in FIG. 8(f). The semiconductor chip 300 can be handled as an ordinal IC chip.

[0044]

The present embodiment can be combined with the second embodiment in the formation of the protective member 14. FIG. 9 shows the modification. The protective member 14 protecting the front surface of the semiconductor chip 300 is formed to expose the pad portions 21 and the dicing-cut portion 22 from an opening portion 23. Accordingly, the wire-bonding step can be performed to the semiconductor chip 300 similarly to the acceleration sensor 31 shown in FIG. 5.

[0045]

Thus, according to the present embodiment, the same effects as those in the first and second embodiments can be provided. In addition, even when the movable portions 10 are exposed from both surfaces of the semiconductor wafer 11, the movable portions 10 can be protected appropriately.

At the dicing-cut step, two types of dicing blades may be used in accordance with the characteristics of the adhesive sheet 42 to lengthen the life-time of the dicing blades. Specifically, a first blade cuts (i.e., partially cuts) the semiconductor wafer 11 to some extent as indicated by arrow C1 in FIG. 8(d), and then, a second blade cuts the remaining semiconductor wafer 11, the adhesive film 42, and the dicing tape 12a as indicated by arrow C2 in FIG. 8(d). The second blade is thinner than the first blade and made of material

different from that of the first blade. Thus, two-step cutting may be carried out.

[0046]

In the state shown in FIG. 8(b), when the thickness of the protective sheet 1 (protective member 14) is increased to, for example, 50 μm, the semiconductor wafer 11 can be cut from the back surface thereof.

The protective member 14 has the cap portion 5 not to contact each movable portion 10 in the embodiments described above. The cap portion 5 is formed by the jig 4 having the recesses 2. However, as shown in FIG. 10, an adhesive 52 may be disposed on a flat protective member 51 where the movable portions 10 of the semiconductor wafer 11 do not conflict. Accordingly, the protective member 51 can be prevented from contacting the movable portions 10 by the adhesive 52. The adhesive 52 may adhere the adhesive film.

The protective member 51 is formed by disposing the adhesive 52 on the flat protective sheet 1, and by forming the grooves 6 (or the opening portions 23) in the protective sheet 1. In this case, the jig 4 can dispense with the recesses 2, resulting in omitting a process for forming the recesses 2.

[0047]

(Fourth Embodiment)

FIGS. 11(a) to 11(e) show a method for producing a semiconductor device in a stepwise manner in a fourth preferred embodiment. In the fourth embodiment, as shown in FIG. 11(a), movable portions 61 are formed in the semiconductor wafer 11 at a

depth in a range of approximately 0.5 to 100 μm from a surface 60 of the wafer 11.

[0048]

In the present embodiment, specifically, a depth of a recess 62 defined by each movable portion 61 and the surface 60 is set to approximately 3 μm. In this state, a protective member (protective cap) 63 may be flat without any convexity or concavity. Therefore, in the present embodiment, the jig fixation step, the protective sheet region removal step, the wafer bonding step, the back side protective sheet bonding step are performed as described above, while keeping the protective film 1 flat without forming the cap portions 5, thereby forming the state shown in FIG. 11(b).

[0049]

Next, as shown in FIGS. 11(c) and 11(d), the dicing-cut step and the protective member removal step are carried out as in the third embodiment, thereby forming a semiconductor chip (semiconductor device) 400 shown in FIG. 11(e).

The protective member 63 may be formed as in the second embodiment. FIG. 12 shows the semiconductor chip 400 formed accordingly to have the protective member (protective cap) 63 exposing the pad portions 21 therefrom. The semiconductor chip 400 shown in FIG. 12 can undergo the wire-bonding step while holding the protective member 63 as in the second embodiment.

[0050]

Although the movable portions 10 are exposed from both front and back surfaces of the semiconductor wafer 11 in the present embodiment, the movable portions 10 may be exposed only from the

front surface of the semiconductor wafer 11 as in the first and second embodiments provided that the movable portions 10 are formed in the wafer at a depth in a range of approximately 0.5 to 100 μm from the front surface of the wafer.

Thus, according to the present embodiment, the same effects as those in the first to third embodiments can be provided by applying the flat protective sheet (protective member 63) 1 to the semiconductor wafer 11 having the structure described above.

[0051]

(Fifth Embodiment)

In a fifth preferred embodiment, a semiconductor chip 500 formed by dicing a semiconductor wafer 11 has bumps exposed therefrom for being electrically connected to external portions. The semiconductor chip has an opening portion for exposing the surface of the semiconductor chip. Further, the surface of the semiconductor chip is covered with the protective member for protecting the semiconductor chip while the dicing-cut step. The bump is exposed from the opening portion of the semiconductor chip.

[0052]

FIGS. 13(a) to 13(e) show a method for producing the semiconductor chip 500 in the fifth embodiment in a stepwise manner. In FIG. 13, the semiconductor wafer 11 has the movable portions formed in the wafer at a predetermined depth from the surface of the semiconductor wafer. Here, the movable portion is to be exposed from both surfaces of the wafer.

First, at a bump formation step shown in FIG. 13(a), bumps 70 for connecting to the external circuit are formed on the front

surface of the semiconductor wafer 11 to be electrically connected to the pad portions 21. The bumps 70 are formed from, for example, eutectic solder or solder including In. Stud bumps (wire bumps) composed of gold balls, which are formed by wire bonding of gold wires, may be adopted as the bumps 70.

[0053]

At the jig fixation step, the protective sheet 1 is fixed to the jig 4 by vacuum absorption. Then, at the protective sheet region removal step, the protective sheet 1 is partially removed by excimer laser or the like to have recesses 71 at regions corresponding to movable portions 61 of the semiconductor wafer 11. The recesses 71 have the same function as that of the cap portions 5 described above.

At the protective sheet region removal step, the grooves 6 are further formed in the protective sheet 1 fixed to the jig 4 at regions (scribe regions) where the dicing-cut is to be performed, thereby dividing the protective sheet 1 into pieces each having a size corresponding to each semiconductor chip by using a cutting means with a press method or a cutter. At that time, regions of the protective sheet 1 corresponding to the bumps 70 are also removed to form opening portions 72.

[0054]

Next, the adhesive film 42 is bonded to the back surface of the semiconductor wafer 11 similar to the above described back side adhesive sheet bonding step. At the wafer bonding step in the present embodiment, protective members 73 formed by dividing the protective sheet 1 are bonded to the front surface of the

semiconductor wafer 11 to expose the bumps 70 from the opening portions 72 while being fixed to the jig 4. As a result, the state shown in FIG. 13(b) is provided.

[0055]

After the protective sheet 1 is detached from the jig 4, the dicing-cut step is carried out along the grooves 6 to divide the semiconductor wafer 11 into chips (see FIG. 13(c)). Accordingly, a semiconductor chip 500 shown in FIG. 13(d) is obtained.

The semiconductor chip 500 is covered with the protective member 73 having the opening portions 72, and the bumps 70 are exposed from the opening portions 72 on the surface of the semiconductor chip 500.

[0056]

Further, a substrate 80 having a conductive layer (i.e., conductive portion) 81 thereon is prepared. The substrate 80 is preferably a ceramic, a printed circuit board or the like. The conductive layer 81 is made of conductive material. The conductive layer 81 disposed on the substrate 80 is covered with an insulating layer 82 having opening portions so that the conductive layer 81 is partially exposed from the opening portions.

Then, the semiconductor chip 500 is disposed on the substrate 80 so that the bumps 70 contact the conductive layer 81 exposed from the opening portions (See FIG. 13(e)). The bumps 70 and the conductive layer 81 exposed from the opening portion of the insulation layer 82 are electrically connected to each other by reflow or thermo compression bonding. Thus, a face down bonding, i.e., a flip chip mounting can be carried out.

[0057]

When the bumps 70 are made of eutectic solder, the melting point of the eutectic solder is approximately 180 ℃. In this case, preferably, the base constituting the protective member 73 is made of heat resistant resin such as polyimide, and silicone adhesive is used as the adhesive described above. The bumps 70 can be made of solder including In, a melting point of which is lower than that of eutectic solder. The bumps 70 and the conductive layer 81 can be connected to each other in a solid phase by thermal compression bonding at a lower temperature. Otherwise, the bumps 70 may be connected by silver paste, which is generally used for fixation of chips onto a substrate.

[0058]

Thus, according to the present embodiment, scraps of the protective member 73 are hardly produced because the dicing-cut is performed along the grooves 6. Therefore, the semiconductor chip 500 is not contaminated by the scraps. Because the protective member 73 needs not be removed from the semiconductor chip 500, the protective member 73 can be bonded to the semiconductor chip 500 firmly. As a result, the separation of the protective member 73 is prevented.

[0059]

The semiconductor chip 500 can be electrically connected to the external substrate 80 by the bumps 70 exposed from the opening portions 72 while holding the protective member 73 thereon.

At the protective sheet region removal step in the present embodiment, it is sufficient to form only the opening portions 72

corresponding to the bumps 70. The grooves 6 may not be formed. In this case, the protective sheet 1 is cut along with the wafer 11 at the dicing-cut step. Even in this case, because the protective member needs not be removed from the semiconductor chip and the protective sheet 1 can be bonded to the semiconductor wafer 11 firmly, contamination of the scraps of the protective sheet 1 and separation of the protective sheet 1 can be prevented.

[0060]

The protective sheet 1 in the present embodiment may have the cap portions 5 as shown in FIG. 1, or be flat as shown in FIGS. 10 and 11.

The movable portions may not be exposed from both surfaces of the semiconductor wafer, but may be exposed from only one surface of the wafer as indicated in the first embodiment.

[0061]

Incidentally, in the embodiments described above, as shown in FIGS. 5 to 7, 9, 12, and 13(d), the semiconductor chip (i.e., sensor chip) 200, 300, 400, or 500 is covered with the protective members 14, 15, 63, or 73, and a peripheral edge portion S1 of each protective member is disposed at an inside of a peripheral edge portion S2 of each semiconductor chip.

[0062]

This is because the region of the protective sheet 1 where the dicing-cut is preformed are removed at the protective sheet region removal step to form the grooves 6 or the opening portions 23.

Because the peripheral edge portion S1 of the protective

member 14, 51, 63, 73 is disposed at the inside of the peripheral edge portion S2 of the semiconductor chip 200-500, it is difficult for the dicing blade to contact the protective member at the dicing-cut step. Here, the protective member 14, 51, 63, 73 protects the semiconductor chip 200-500 at the dicing-cut step. As a result, the scraps of the protective sheet are hardly produced, and the separation of the protective member does not occur.

[0063]

Further, in the semiconductor chip 200-500, since the semiconductor chip is still covered with the protective member after the dicing-cut step, the protective sheet 1 for the dicing-cut is also bonded firmly. Therefore, the separation of the protective member is prevented completely.

If the peripheral edge portions of the protective member and the semiconductor chip are provided at the same position, the protective member is liable to be separated from the chip when the side faces, the upper angular portions, the peripheral portion or the like of the chip are handled or pinched. As opposed to this, in the semiconductor chip 200 to 500, because the peripheral edge portion S1 of the protective member is disposed at the inside of the peripheral edge portion S2 of the chip not to contact other members, the separation of the protective member hardly occurs during the handling.

[0064]

Accordingly, in the semiconductor chip 200-500, the chip is prevented from being contaminated with the scraps of the protective sheet. Further, the separation of the protective sheet is

suppressed.

(Other Embodiments)

The semiconductor device in the present invention may be composed of a semiconductor chip encapsulated with resin.

[0065]

In the embodiments described above, the protective members have various structures such as a cap portion, a gap defined by adhesives, and a recess corresponding to the movable portion and formed by excimer laser, thereby preventing contact with the movable portions of the semiconductor wafer. Further, the protective member may have a flat shape in some cases. However, the structure of the protective member is not limited to those.

[0066]

Further, the embodiments described above can be combined with one another selectively and appropriately.

In the embodiments described above, although several protective members are formed from one protective sheet fixed to the jig, the protective members may be individually formed and fixedly arranged on the jig so that the protective member is bonded to the semiconductor wafer.

The present invention is not limited to a semiconductor device having a movable portion, but can be applied to other semiconductor devices and methods for producing the devices by cutting a semiconductor wafer covered with a protective sheet into chips by dicing.

[BRIEF DESCRIPTION OF THE DRAWINGS]

[FIG. 1] FIGS. 1(a) to 1(e) are cross-sectional views explaining a method for producing a semiconductor device according to a first embodiment of the present invention.

[FIG. 2] FIGS. 2(a) to 2(c) are cross-sectional views showing the method for producing the semiconductor device continuing from FIG. 1(e).

[FIG. 3] FIGS. 3(a) to 3(e) are cross-sectional views explaining a method for producing a semiconductor device according to a second embodiment of the present invention.

[FIG. 4] FIGS. 4(a) and 4(b) are cross-sectional views showing the method for producing the semiconductor device continuing from FIG. 3E.

[FIG. 5] FIG. 5 is a cross-sectional view showing the semiconductor device in the second embodiment.

[FIG. 6] FIG. 6 is a plan view schematically showing a protective member of the semiconductor device in the second embodiment.

[FIG. 7] FIG. 7(a) is a cross-sectional view schematically showing a modified protective member of the semiconductor device in the second embodiment, and FIG. 7(b) is a plan view schematically showing the modified protective member of the semiconductor device in the second embodiment.

[FIG. 8] FIGS. 8(a) to 8(f) are cross-sectional views explaining a method for producing a semiconductor device according to a third embodiment of the present invention.

[FIG. 9] FIG. 9 is a cross-sectional view showing a modified semiconductor device in the third embodiment.

[FIG. 10] FIG. 10 is a cross-sectional view showing a case where a flat protective member is used.

[FIG. 11] FIGS. 11(a) to 11(e) are cross-sectional views explaining a method for producing a semiconductor device according to a fourth embodiment of the present invention.

[FIG. 12] FIG. 12 is a cross-sectional view showing a modified semiconductor device in the fourth embodiment.

[FIG. 13] FIGS. 13(a) to 13(e) are cross-sectional views explaining a method for producing a semiconductor device according to a fifth embodiment of the present invention.

[DESCRIPTION OF REFERENCES]

Reference 1 represents a protective sheet,

reference 4 represents a jig,

reference 6 represents a groove,

reference 11 represents a semiconductor wafer,

references 14, 51, 63 and 73 represent protective members (i.e., protective chaps),

reference 21 represents a pad portion,

reference 23 represents an opening portion,

reference 33 represents a wire,

reference 42 represent an adhesive sheet,

reference 70 represents a bump,

reference 72 represents an opening,

reference 80 represents a substrate,

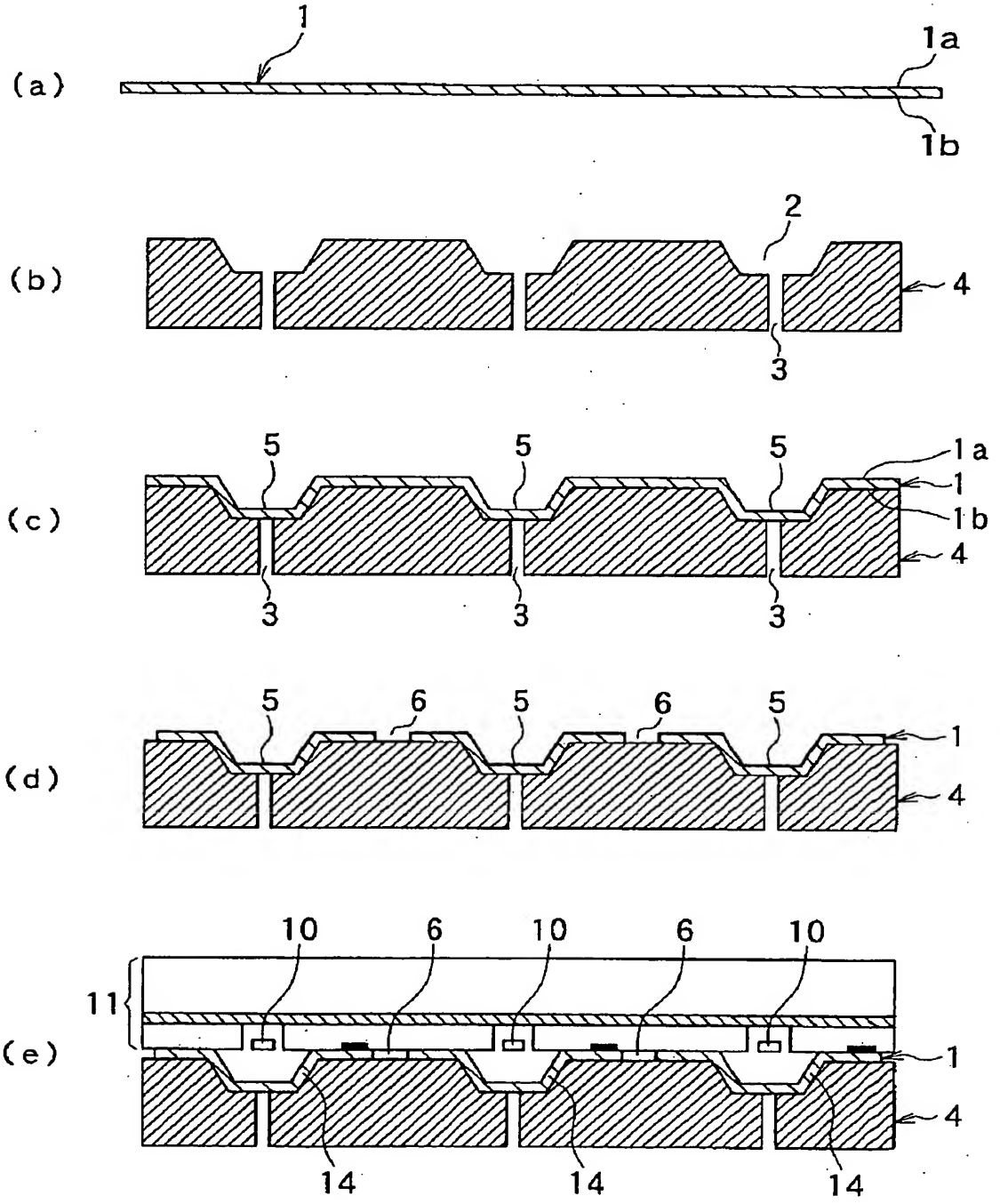
reference 81 represents a conductive layer, and

references 200, 300, 400 and 500 represent semiconductor

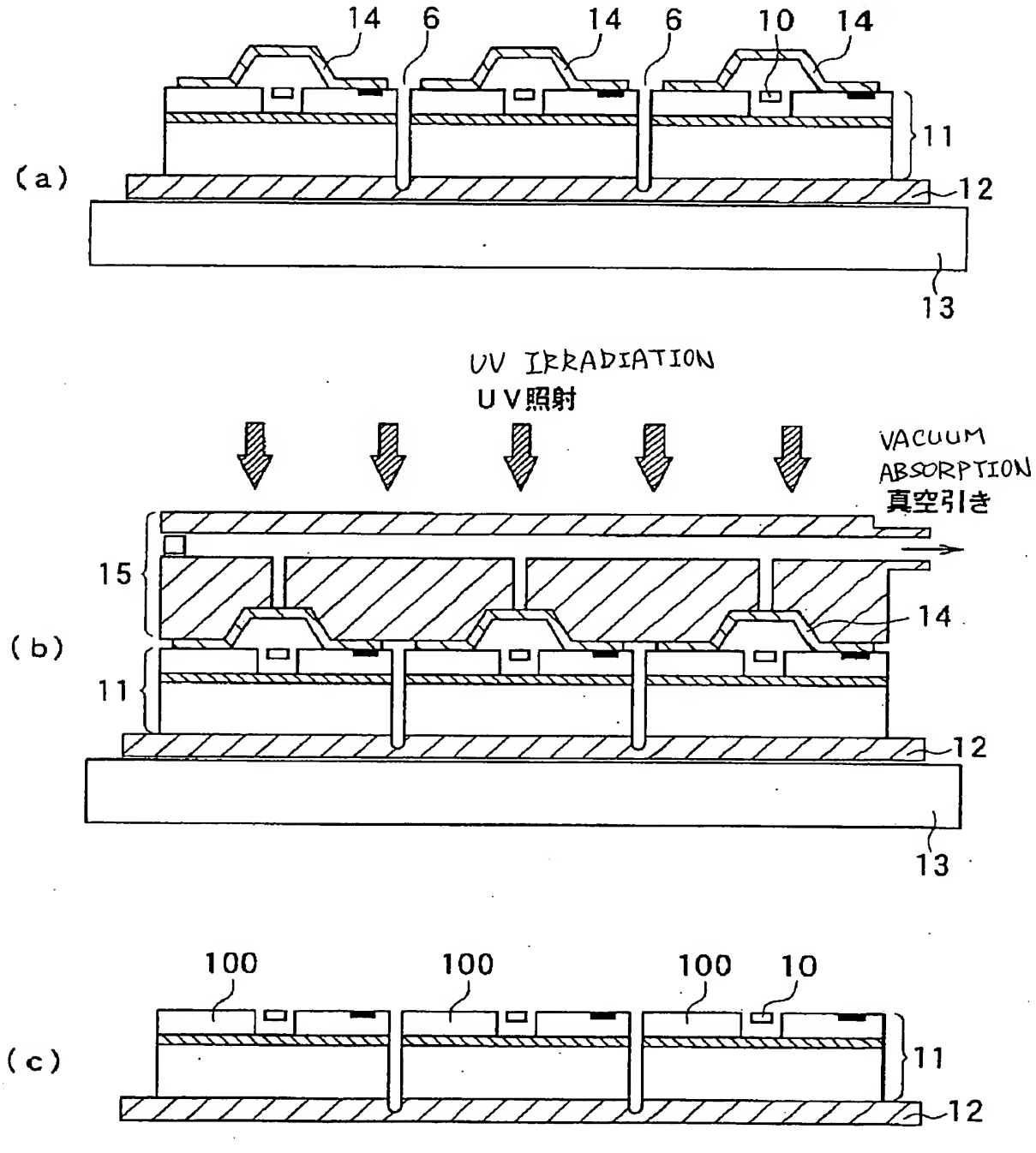
chips.

【書類名】 図面 [NAME OF DOCUMENT] DRAWINGS

【図１】
[FIG.1]



【図２】
[FIG.2]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UV照射
VACUUM
ABSORPTION
真空引き
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(c)
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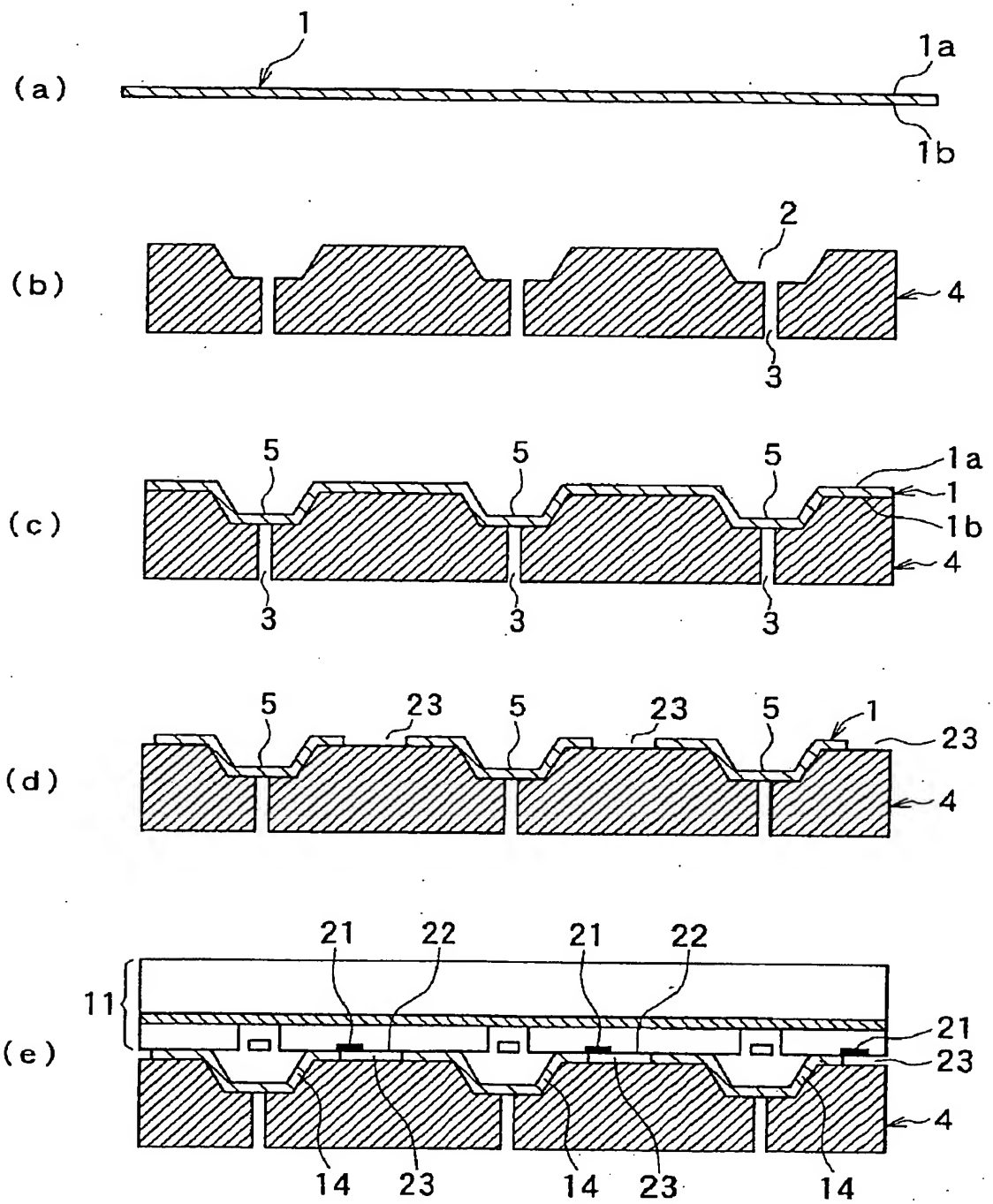
100
10
11
12

【図３】

[FIG.3]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(d)
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5
23
5
1
23
4
(e)
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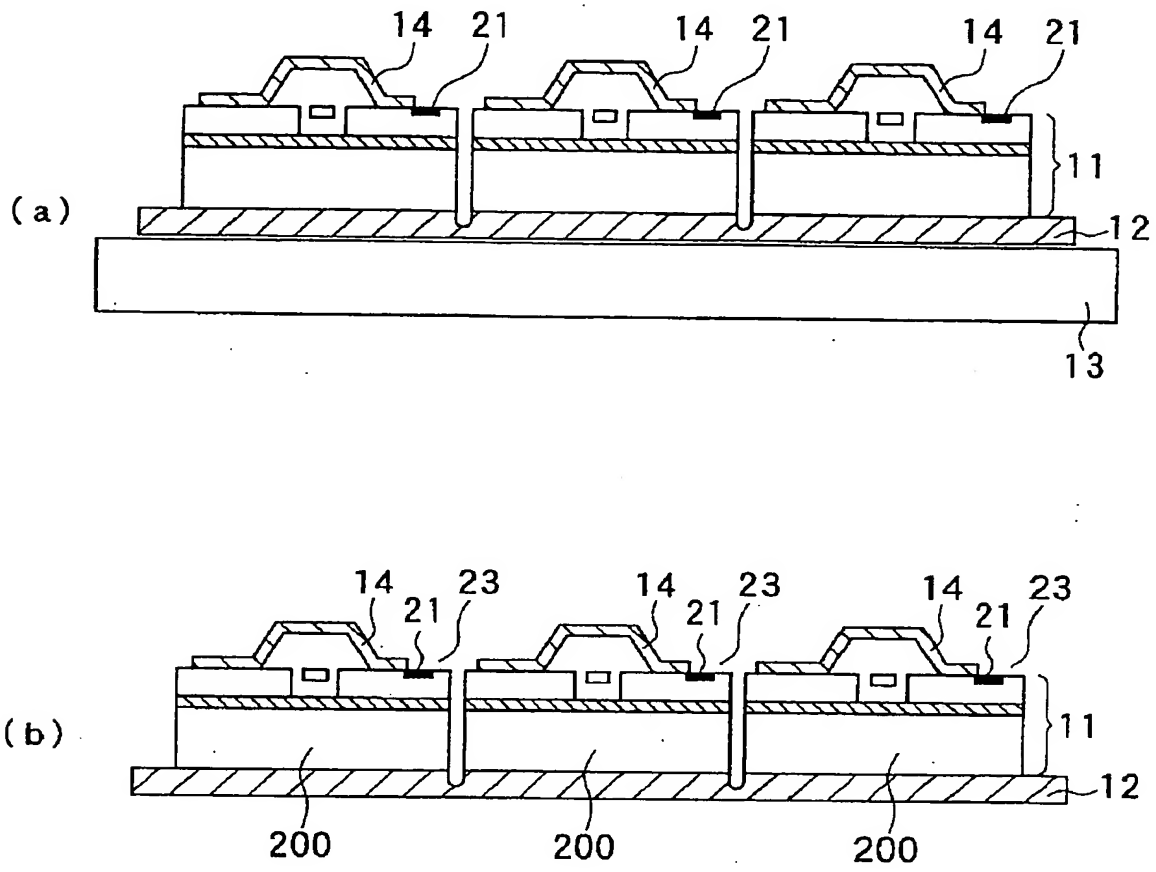
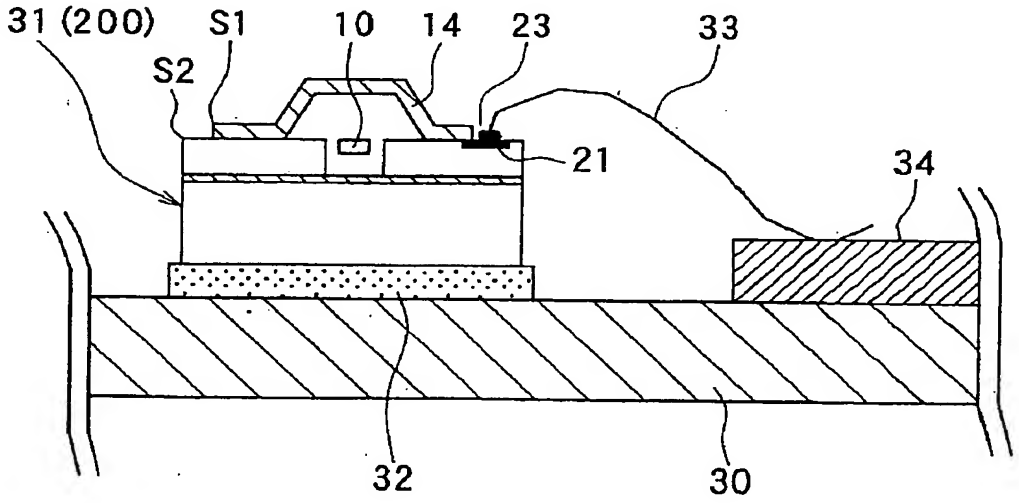
23
14

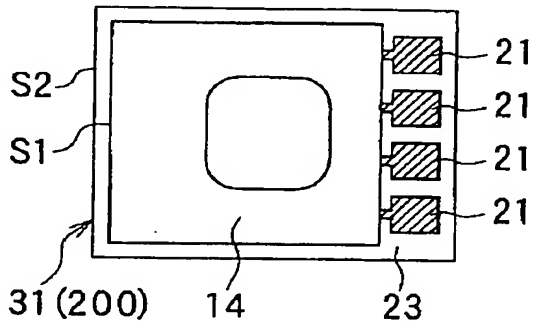
【図４】
〔FIG.4〕



【図５】
〔FIG.5〕

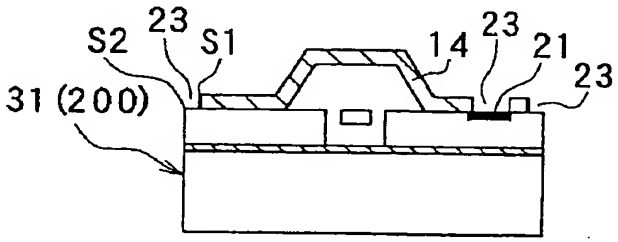


【図６】
〔FIG.6〕

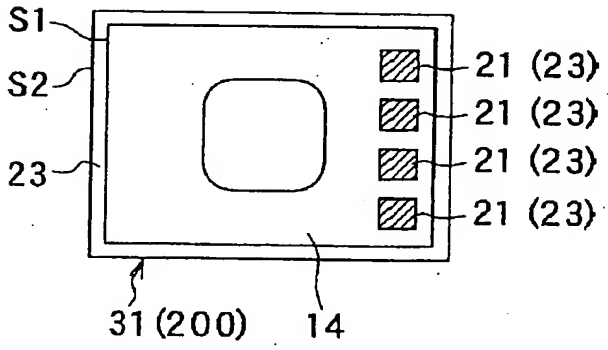


【図７】
〔FIG.7〕

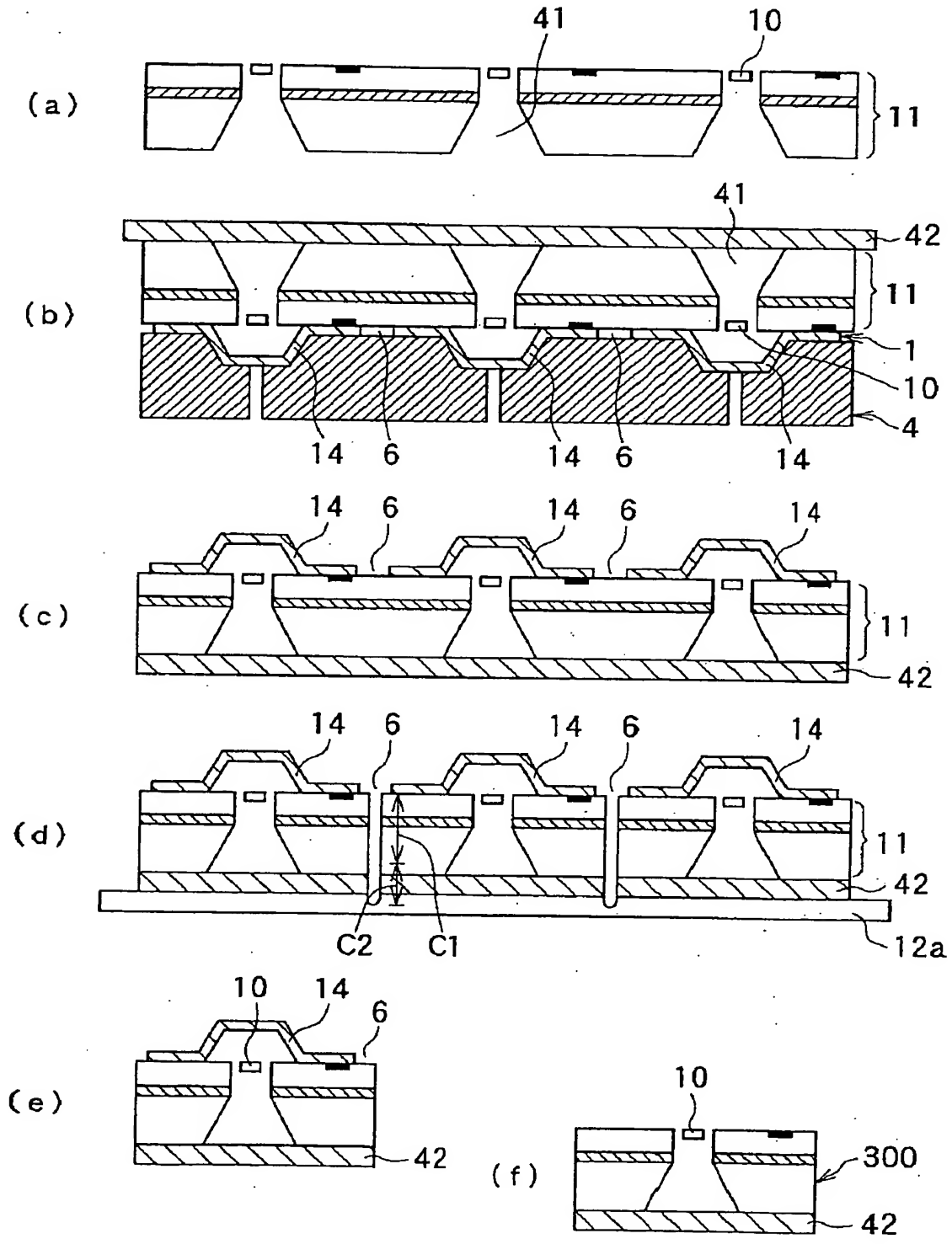
(a)



(b)



【図８】
[FIG.8]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(b)
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4
14
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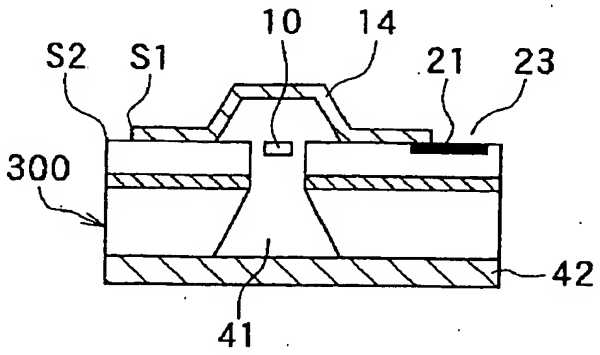
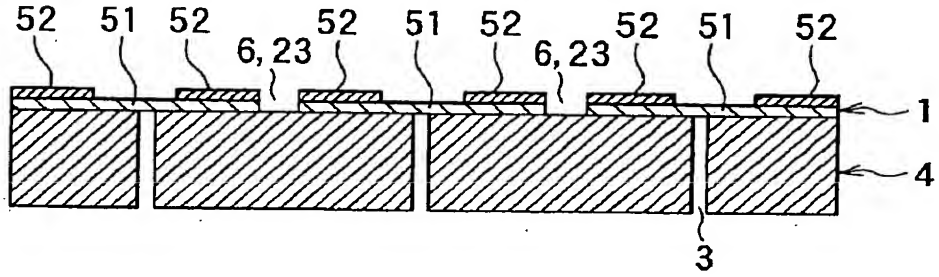
14
(c)
14
6
14
6
14
11
42
(d)
14
6
14
6
14
11
42
C2
C1
12a
(e)
10
14
6
42
(f)
10
300
42

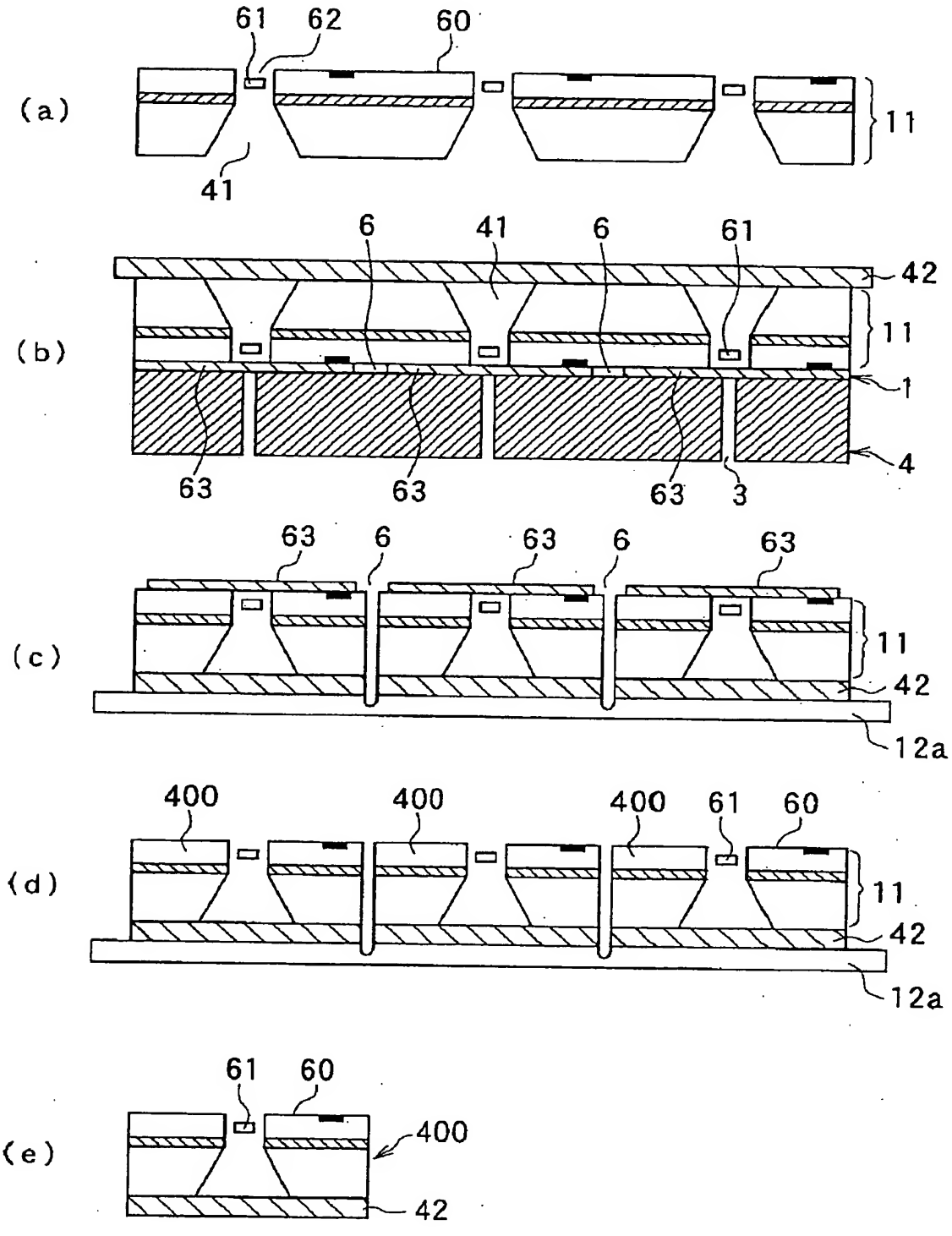
【図９】
[FIG.9]



【図１０】
[FIG.10]



【図１１】
[FIG.11]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(b)
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1
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42
12a
(d)
400
400
400
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12a
(e)
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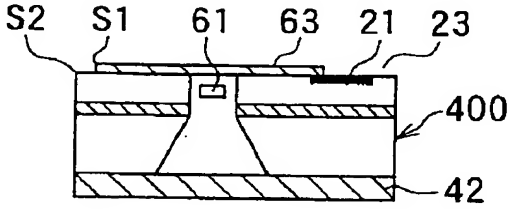
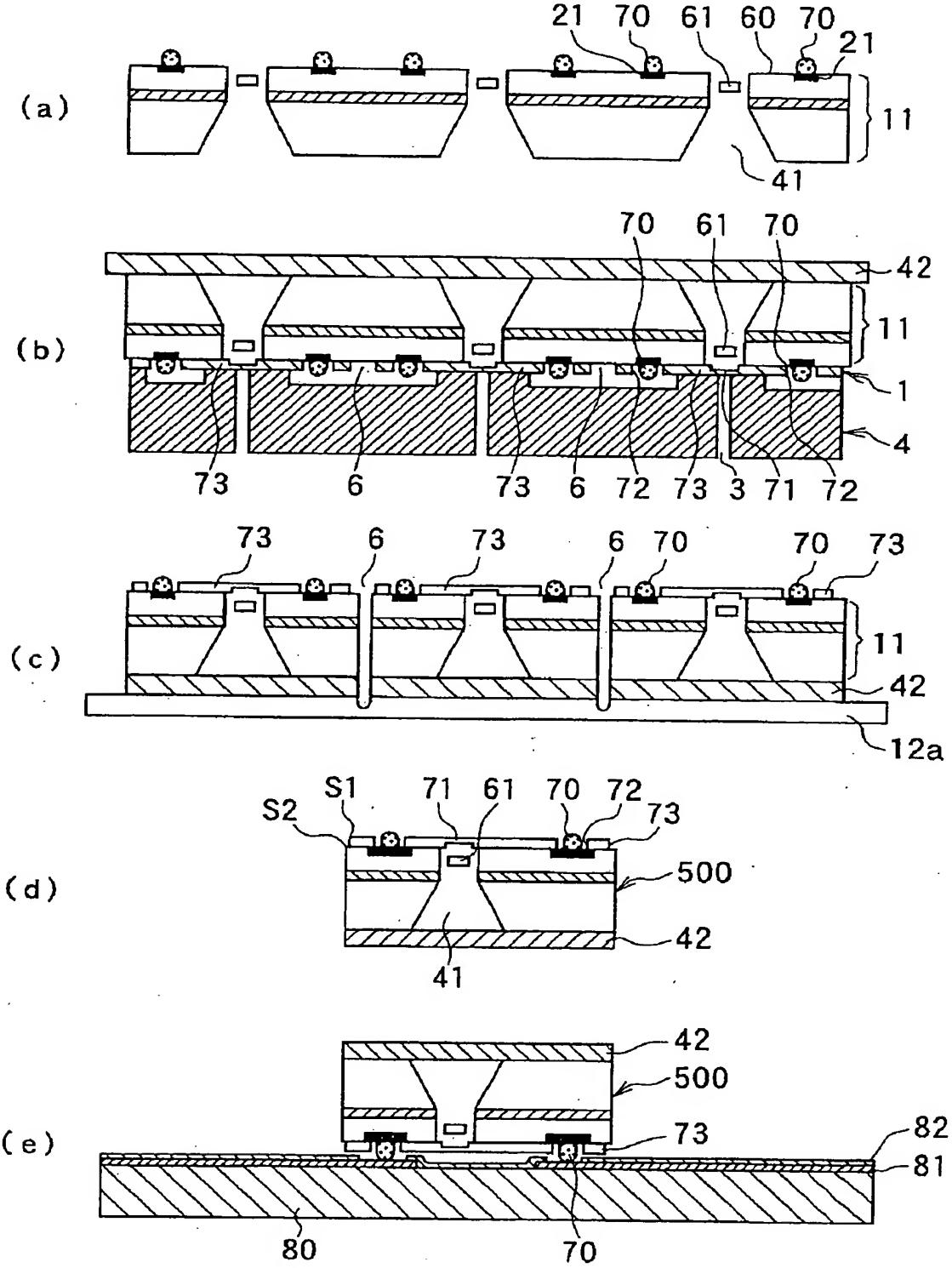
60
400
42

【図１２】
[FIG.12]



【図１３】

[FIG.13]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6
72
73
3
71
72
(c)
73
6
73
6
70
70
73
11
42
12a
(d)
S1
71
61
70
72
S2
73
500
42
41
(e)
42
500
73
82
81
80
70

[NAME OF DOCUMENT] ABSTRACT

[ABSTRACT]

[OBJECT]

To provide a semiconductor device and a method for producing the semiconductor device, which is prevented from being contaminated by scraps of a protective sheet produced when a semiconductor wafer covered with the protective sheet is cut by dicing to form the semiconductor device. Another object of the present invention is to provide a semiconductor device and a method for producing the semiconductor device capable of preventing separation of the protective sheet.

[CONSTITUTION]

A method for producing a semiconductor device, includes the steps of: fixing a protective sheet 1 to a jig 4 at an opposite side of the protective sheet opposite to a surface of the protective sheet for covering a semiconductor wafer 11; removing a dicing-cut region of the protective sheet 1 fixed to the jig 4; bonding the semiconductor wafer 11 to the protective sheet 1 at an opposite side of the jig, the protective sheet 1 being fixed to the jig 4; detaching the protective sheet 1 and the semiconductor wafer 11 from the jig 4, the semiconductor wafer 11 being bonded to the protective sheet 1; and cutting the semiconductor wafer 11 along a groove 6 as the dicing-cut region of the protective sheet 1 by dicing.

[SELECTED FIGURE]

FIG. 1